Investigation of beam brilliance of high current Ta-beam on HOSTI in the frame of compact-LEBT project

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With the coming FAIR project the requirements for beam brilliance will be significantly higher compare to the values provided by existing high current injector. Therefore it is planned to build up a separate injector (Terminal West and Compact LEBT) designed specially for production of high current uranium beams [1]. Also it is necessary to improve and optimize the setup of high current uranium ion sources including extraction and DC post-acceleration systems. These improvements can be performed and demonstrated on high current test injector HOSTI [2].

In 2011 at HOSTI injector the setup has been modified. A new post acceleration system designed for maximum 150 kV voltage was installed. It is much more compact compare to the old one with reduced drift to the first focusing beamline element by 0.8 m. As a result ion beam losses are reduced as well (Fig.1).

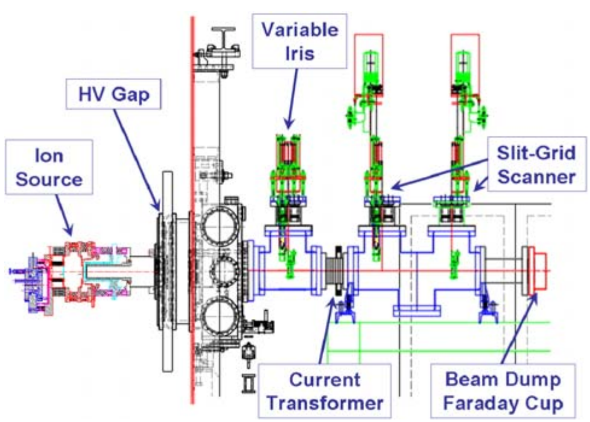

Figure 1: Scheme of the HOSTI setup with a new post acceleration system.

Several sets of measurements have been performed at HOSTI using high current non-radioactive ion beams (Ta, Ti and Ar) [3]. Different aspects related to improvement of performance of high currents ion sources were studied: mainly the investigation of beam brilliance of high current Ta-beam provided by vacuum arc ion source VARIS as function of beam aperture. The aperture of the ion beam was controlled with a variable iris installed directly behind the post-acceleration system (Fig.1). The measurements are shortly summarized in Fig.2. It is shown that there is an optimum beam aperture size with highest brilliance between 45 and 60 mm (iris aperture).

Measurements with various apertures of HV-electrodes in the post-acceleration gap have shown a strong influence of electrostatic beam compression in the gap on the beam emittance (Fig.3). Therefore the optimization of electrodes geometry in the post-acceleration system is one of the promising ways to increase the beam brilliance.

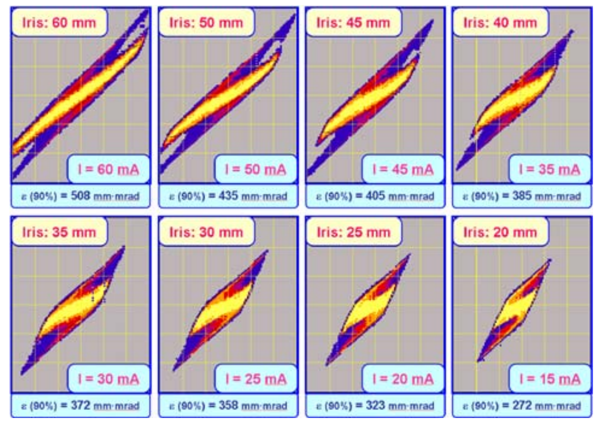

Figure 2: Emittance and current measurements of tantalum ion beam for various iris apertures with fixed ion source settings.

Various extraction systems have been tested and compared in order to achieve a more brilliant ion beam core: single hole, 7-holes and 13-holes (standard). It was proved that 13-holes extraction system is optimal for ion beam apertures ⩾50 mm. While for small beam apertures (⩽40 mm) 7-holes system is advantageous. A single hole extraction system is not suitable for production of high current beams, however it provides the most brilliant beam core.

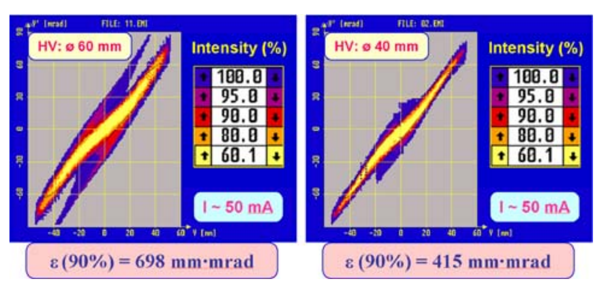

Figure 3: Emittance of Ta-beam with ø60 mm HV electrode (left) and with ø40 mm HV electrode (right).

References

[1] H. Vormann et al., this report

[2] A. Adonin, R. Hollinger, and P. Spädtke, Rev. Sci. Instrum. 81, 02B707 (2010)

[3] A. Adonin and R. Hollinger, Rev. Sci. Instrum. 85, 02A727 (2014)

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